MODULE 2

INTRODUCTION TO THE ESSENTIAL RESOURCES: COASTAL ENVIRONMENTAL SYSTEMS

The Essential Resources: Coastal Environmental Systems

OBJECTIVES:

- To provide an introduction to and a basic understanding of the major coastal environmental systems that exist in the Caribbean.
- To describe the common environmental damages caused by poor tourist facility design.

OVERVIEW:

- Introduction to Natural Resources: definition, classification of resource types - Stock and Flow
- Resources Utilization: provision of raw materials, waste assimilation and provision of life support services; economic environmental linkages; sources of degradation
- Tourism and the Environment: contribution to Caribbean economics; detrimental impacts of coastal tourism
- Carrying Capacity: site vulnerability, resource sensitivity, patterns of use, tourism-specific factors, socio-cultural factors; environmental indicators
- Matrix of environmental indicators

INTRODUCTION TO NATURAL RESOURCES

Ideas as to what constitutes resources have changed over time. Such changes were in response to increased knowledge, technical improvements and socio-economic changes (economies, tastes, trends, etc.).

The fundamental issues in natural resource management, environmental economics, and general development planning revolve around the definition of resources and the allocation of the welfare derived from, or costs associated with, the use of said resources.

Natural Resources Defined

A resource may be defined as a device, material, or skill that can be utilized to fulfill a function. Natural resources are therefore those naturally occurring substances that are utilized by man for life-support purposes.

These resources are generally divided into two main categories: Stock Resources and Flow Resources (Figure 1).

Stock Resources

Stock resources are those which have taken millions of years to form and are perceived to be finite in their supply. This class of resources includes land, minerals, and fossil fuels.

The matter of the "finiteness" of such resources is still debatable, as technology allows for some resources (such as most metals) to be recycled many times. For other resources, the by-products of their use provide raw materials (resources) for other uses.

The quantity of a stock resource that is available for use depends on technological changes in accessing new resources, making viable previously "exhausted" sources, or recovering supplies previously inaccessible.

Typically, economists refer to that part of the stock that is available as the resource; it is this definition of a resource that initially led to the development of the discipline of Resource Management.

Module 2 - Figure 1
Classification Of Resource Types

STOCK RESOURCES		
Consumed by Use	Theoretically Recoverable	Recyclable
OIL GAS COAL	ALL ELEMENTAL MINERALS	METALLIC MINERALS

FLOW RESOURCES	
Critical Zone	Non-critical Zone
FISH FORESTS ANIMALS SOIL WATER IN AQUIFERS	SOLAR ENERGY TIDES WIND WAVES WATER AIR

Flow resources used to extinction

Critical Zone resources become Stock once regenerative capacity is exceeded

Flow Resources

Flow resources are often referred to as Renewable Resources because they are regenerated within relatively short life spans. These include water, air, animal and plant life, tidal energy, and wind energy.

Flow resources themselves fall into two categories; those which are independent of human activity (wind, solar, and tidal energy) and those which are dependent (plant and animal life and water).

It is possible to exploit the majority of these resources to levels below their capacity to reproduce or regenerate. These are sometimes referred to as Critical Zone Resources. Others may become useless or scarce in the short-term due to pollution (water and air) or overuse (fuel wood and lumber). Resources that can also become unavailable through overuse or misuse include soils and ground water (aquifers).

Related Terms

A number of other terms are usually used in discussions concerning resources. A number of these terms are given below.

Resource Base

The resource base is defined as the total quantity of the resource within the global system. It can also mean the total resources in a given area. This term was traditionally used in relation to stock resources, but now encompasses renewable resources. The regenerative capacity of renewable resources makes it impossible to calculate the amount available over time.

Reserves

Reserves are the parts of the resource that can be exploited using current technology. Reserves usually refer to stock resources and are further subdivided into proven reserves, conditional reserves, hypothetical resources, speculative resources, and ultimately recoverable resources (Rees, 1990).

Proven Reserves

"Proven reserves are defined as deposits already discovered and known to be economically extractable under current demand, price and technological conditions" (Rees 1990). From the definition it is obvious that proven reserves are not fixed quantities, as they depend upon judgements and set profit margins.

Different assemblages of these natural resources form "characteristics" groupings, commonly referred to as ecosystems. An ecosystem can be defined simply as a biological community of interacting organisms and their physical environment.

Typical coastal ecosystems are:

- Coastal terrestrial communities
- Beaches
- Wetlands (freshwater & saltwater)
- Rocky shorelines
- Seagrass beds
- Coral reefs
- The benthos (bottom-dwelling communities)
- The open ocean (pelagic communities)

Due to the interaction between the biological and physical elements of an ecosystem, the ecosystem produces goods and services in excess of that provided by its component parts, (Table 1) hence identifying the "life-supporting process" of ecosystems.

RESOURCE UTILIZATION

Both the individual resources and the ecosystem are used in the many and varied activities carried out in support of human existence. Resource utilization falls within three basic groups:

a. Provision of Raw Materials
This includes direct consumption of resources such as plants, animals, air, water, etc; as well as provision of raw materials, such as minerals, forest products, fuels, etc.

b. Waste Assimilation
Disposal of waste at sea, in rivers, in wetlands, and in soil. In some cases, this action is considered to be based on the capacity of ecosystems to assimilate small amounts of different types of waste. More recently, "natural systems" are being created for the treatment of waste such as sewage.

c. Provision of Life-support Services
Most of these ecosystem functions occur independently of human activities, although these activities could affect the proper functioning of the receiving systems. Life-support services include disaster mitigation, pest control, provision of oxygen, and similar services. Humans also depend on these services to fulfill a range of necessities, from purely recreational to spiritual.

These resources are used to meet the basic needs of the general population, as well as to support the diverse, and often conflicting, development patterns of each sector of the economy. Unfortunately, the present development strategies and associated patterns of resource use result in the deterioration of environmental resources.

Economic/Environment Linkages

Economic/environment linkages are numerous, and are both direct and indirect. Direct linkages include the use of stock resources, the use of flow resources as raw materials, and agricultural activities. Indirect linkages include ecosystem functions, use for waste disposal, and recreational use.

The exploitation of stock resources (minerals and fossil fuels) has been a major factor in generating industrial and economic growth. Contribution to national development may depend less on ownership than on patterns of exploitation, refining and trade.

Regardless of the patterns of exploitation, the contribution to development cannot be denied. Future patterns of exploitation are likely to follow past patterns, since the patterns of ownership and exploitation remain the same. In such an event, the related environmental degradation will continue.

Module 2 - Table 1:

Natural & Economic Functions Of Selected Ecosystems

ECOSYSTEM	FUNCTION
Forests	↳ Flood protection ↳ Provide resins, oils, medicines ↳ Ensure water availability ↳ Provide food and drink ↳ Erosion prevention ↳ Provide fuelwood and charcoal ↳ Provide lumber/timber ↳ Habitat for wildlife species ↳ Support tourism
Wetlands	↳ Flood control ↳ Fish and shrimp nursery ↳ Sediment trap (improved surface runoff to the sea) ↳ Land building (sediment trap) ↳ Protect the shorelines from wave energy and storms ↳ Act as habitat for birds, crocodiles, and other wildlife species ↳ Provide a source of food material for nearby coral reefs ↳ Provide materials for construction, fishing and craft ↳ Tourism and other forms of recreation
Coral Reefs	↳ Provide habitat for fish and other marine organisms ↳ Protect coastline from wave action ↳ Provide material for sandy beaches ↳ Tourism and other forms of recreation
Seagrass Beds	↳ Function as nurseries for juvenile fish and shellfish ↳ Prevent shoreline erosion by reducing wave energy, and ↳ binding the sand together ↳ Export food materials to nearby coral reefs

Flow resources have also contributed directly to economic growth through the provision of raw materials. These have included lumber and other forest products, fish, water for industrial purposes, and the sale of wild animals and related products endangered species have changed the nature of the economic contribution from this source. Economic contribution is increasingly indirect (e.g. through visitation to national parks and protected areas).

Indirect Linkages

The functioning of ecosystems contribute directly to economic growth in many ways (Table 1). These contributions are inherent in the ecological processes that define these systems.

They include:

- wetlands (land building, reef protection, flood protection, prevention of coastal erosion, and provision of nurseries for reef fish),
- forests (flood protection, water availability, erosion prevention, fuelwood and charcoal, and resins and oils), and
- other ecotypes that protect land from damage from natural phenomena or provide habitats for wildlife species.

The environment has always been used for waste disposal. This practice ranges from uncontrolled, unregulated inputs of factory waste to semi-regulated disposal of municipal waste and highly regulated disposal of hazardous waste. Traditionally, industrial activities have been developed without environmentally safe measures.

As regulation of polluting activities increased, management of waste turned into a multi-million dollar business; even trade in waste has been attempted. Such attempts in the Caribbean have been either direct or masked as power-generating projects. The ability of the environment to assimilate some level and types of waste has been recognised by leading economists to postulate an optimal level of pollution.

Additionally, waste management and pollution affect economic performance through the effect on technology for waste reduction and indirectly through loss of production and productivity caused by deteriorating health conditions.

Other Indirect Linkages

An increasing contribution to economic growth is made in the area of recreation. Increasing environmental degradation in many countries, coupled with economic growth in the more developed countries, has increased the demand for areas with high amenity value. The acceptance of the concept of ecotourism and the phenomenal growth in this sub-sector is a case in point. Yet another manifestation of the demand for pristine areas is the high cost of land which has high amenity value.

There are a number of other indirect linkages between economics and the environment. Two linkages of special relevance to the Caribbean are global warming and natural disasters.

Global warming is a measurable phenomenon, even if there is not absolute agreement on the sources of the problem and the proportionate contribution from developed versus developing countries. Given the fact that most of the built environment, many of the population centres, much of the renewable resources, and most of the economic activities in the region are located in the coastal area, increase in sea level would create major disruption to existing socio-economic and geo-political arrangements.

An increase in the intensity and frequency of storms would not only reduce the regenerative capacity of ecosystems, it would create major economic problems through damage to buildings, loss of life, loss of agricultural production, damage to infrastructure, and similar impacts.

Sources of Degradation

As stated above, coastal resources support the activities of many sectors of an economy. As such, deterioration of these resources result from many activities and many sources (Table 2). Additionally, many of those sources are located outside the coastal zone. Given the mountainous nature of most of the Caribbean, agents causing coastal degradation travel swiftly from the hinterland to the coastal zone. Most sources of degradation are land-based and can therefore be controlled through development control mechanisms.

UNEP (1994) identifies pollution as the factor presenting the greatest threat to marine and coastal ecosystems and human health; typifying the pollutants as:

- Sewage
- Petroleum hydrocarbons
- Sediments
- Nutrients
- Pesticides
- Litter and marine debris
- Toxic wastes

The above pollutants (except for marine debris) are generated by land-based sources and reach the coastal zone through the following means (UNEP 1994):

a. Point sources (industries and sewage treatment plants),
b. Urban non-point runoff (stormwater runoff and combined overflow discharges),
c. Non-urban, non-point runoff (cropland, pastureland and forestland runoff,
d. Upstream sources (pollutants carried into the coastal zone as part of the river's streamflow), and
e. Irrigation return flows (irrigation water return to a lake, stream, or canal).

TOURISM AND THE ENVIRONMENT

The tourism product in the Caribbean is largely dependent on the physical environment. The advantage of having good environmental qualities is reflected in the traditional marketing approach for Caribbean destinations; that is, selling "sun, sea, and sand". This has resulted in the concentration of tourist facilities in the coastal areas. Coastal waters therefore directly support much of the activities of Caribbean tourism, either through water sports or through the increasing yatching and sailing sub-sector.

Module 2 - Table 2:
Sources Of Coastal Resources Degradation

Source	Activity	Type of Impact
Tourism	Waste generation Recreational Mechanical action/physical change Resource over-use/misuse Beach management Land speculation	Physical Ecological Hydrological Aesthetic Socio-economic Socio-cultural Human health
Industry	Waste generation Physical change	Physical Ecological Hydrological Aesthetic Socio-economic Human health
Solid Waste Disposal	Collection Dumping Burning	Physical Ecological Hydrological Aesthetics Human health
Shipping	Waste generation Mechanical action	Physical Ecological Hydrological Aesthetic Socio-economic Human health
Non-point Source of Pollution	Waste	Physical Ecological Aesthetic Socio-economic Human health
Commercial Activity	Waste generation Physical change	Physical Hydrological Aesthetic Socio-economic Human health Ecological
Housing	Waste generation Recreational Mechanical action/physical change Land speculation	Physical Ecological Hydrological Aesthetic Socio-economic Human health
Overuse of Resources	Recreational Harvesting	Physical Ecological

Source: UNEP, 1998

Contribution of Tourism to Caribbean Economies

Though it is well recognised that tourism has played an increasingly vital role in the economies of the Caribbean, existing information on the economic impacts of tourism does not provide a comprehensive view of the full costs and benefits (CDB, 1996). This is due primarily to the lack of reliable data, as well as a system to adequately measure the benefits of tourism on a country's economy. However, using aggregate measures and assumptions based on multiplier effects, estimates of economic impact are usually derived.

Foreign Exchange Revenues

Data published by the Caribbean Tourism Organization (CTO) for 32 countries of the region showed that visitor arrivals for 1995 amounted to 14.7million stopover visitors and 9.7 million cruise ship passengers (CTO, 1996). This resulted in expenditure estimated at U.S. $12.7 billion (Table 3), an increase of 8.3% over 1994 expenditures.

Revenue from the tourism sector is vital to the economies of these Caribbean states, as it helps to pay for the Region's import bill, and also makes up an increasing percentage of the balance of payments budget (Table 4).

Module 2 - Table 3:

Estimated Foreign Exchange Expenditure (in millions of $US)

Country	1994	1995
Anguilla	51.0	48.7
Antiqua and Barbuda	394.0	328.5
Aruba	450.7	521.2
Bahamas	1,332.6	1,346.2
Barbados	597.6	697.5
Belize	71.4	77.6
Bermuda	525.3	487.9
Bonaire	32.4	37.0
British Virgin Islands	188.1	191.4
Cayman Islands	334.1	375.5
Cuba	850.0	1,100.0
Curacao	240.2	232.7
Dominica	30.6	32.5
Dominican Republic	1,147.5	1,568.4
Grenada	59.3	58.2
Guadeloupe	389.3	458.3
Guyana	47.0	46.5
Haiti	27.0	56.0
Jamaica	973.0	1,068.5
Martinique	378.9	414.8
Montserrat	18.5	15.1
Puerto Rico	1,728.3	1,826.1
St .Kitts	76.9	65.1
St. Lucia	224.1	267.8
St. Maarten	419.1	348.7
St. Vincent and the Grenadines	50.0	56.0
Suriname	.5	13.5
Trinidad and Tobago	13.5	78.1
Turks and Caicos Islands	85.4	62.0
U.S. Virgin Islands	56.5	820.5
Total	**11,712.9**	**12,682.5**

A number of the figures are provisional.
Source: CTO, 1996.

Data from 1985/86 indicate that tourism earnings paid for approximately 40 % of the Caribbean's total imports of approximately US $4 billion/year from the USA (CTRC, 1987). While more recent data is not available, the increase in visitor arrivals and expenditure, and the shortfall in earnings from other sectors, suggest that the Region's dependence on tourism has increased.

Employment statistics are inadequate, as it covers mainly the employment in accommodation establishments. Even with this limitation, employment in accommodations for 1995 was estimated at 192,500 persons. Based on the assumption that indirect employment is three times (3x) employment in the accommodations sub-sector, jobs generated were estimated at 578,000 persons.

Projected Growth in Caribbean Tourism

The Region has experienced a steady growth in tourism during the past two decades, moving from earnings of US $3.5 billion in 1980 (CTR, 1987) to US$12.7 billion in 1995 (CTO, 1996).

Module 2 - Table 4:

Contribution Of Tourism Receipts (Visitor Expenditure) To The Balance Of Payments In 1985 In Selected Countries

Country	Export of Goods & Services ($US million)			Tourism Receipts as % of Total exports
	Tourism Receipts	Other	Total	
Bahamas	995.0	402.0	1,397.0	71.2
Antigua&Barbuda	83.6	40.4	124.0	67.4
Dominica	8.7	25.3	34.0	25.6
Grenada	32.4	19.6	52.0	62.3
Montserrat (1994)	9.8	3.1	12.9	68.4
St. Kitts & Nevis	31.0	18.0	49.0	63.3
St. Lucia	55.7	37.3	93.0	59.9
St. Vincent & the	23.0	57.0	80.0	28.8
Grenadines	14.6	N/A	N/A	N/A
Anguilla	309.0	490.0	799.0	38.7
Barbados	11.1	119.9	131.0	8.5
Belize	97.3	2.7	100.0	97.3
British Virgin Islands	85.5	68.5	154.0	55.5
Cayman Islands	22.0	223.0	245.0	9.0
Guyana	406.8	754.7	1,093.0	37.2
Jamaica	197.3	2,448.7	2,646.0	7.5
Trinidad & Tobago	12.2	N/A	N/A	N/A
Turks &Caicos Island	368.0	367.0	735.0	50.0
Dominican Republic	69.0	161.0	230.0	30.0
Haiti				

Source: CTRC, 1987

Estimates for 1996 by the World Travel & Tourism Council for Caribbean Travel and tourism gross outputs are US $25.4 billion (25.5% of GDP), and employment of 2.37 million persons (22% of total employment). Projected growth for Caribbean tourism over the next decade is estimated at 34.6 % (WTTC, 1996).

The data given above for tourism expenditure is obviously an underestimation of actual expenditures. Sub-sectors such as the restaurant and bar and recreation are not totally tourism oriented. Similarly, the contribution from sub-sectors such as the yachting/sailing sub-sector is difficult to calculate.

> ...the full cost of tourism to the Caribbean remains unknown

In spite of ongoing attempts to fully quantify the contribution of tourism to Caribbean economies, the full cost of tourism to the Caribbean remains unknown. This is due mainly to the fact that such costs are extremely difficult to calculate, primarily for the following reasons:

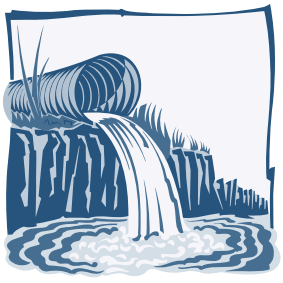
- A substantial amount of imported goods and services are consumed by the sector.
- There is significant leakage in earnings (for the period 1980-1996, it is estimated that only 42% of each dollar earned was retained within the Caribbean as local value added (CTRC, 1987).
- There is no clear indication of the tourism-related component of infra-structure costs.
- Tourism makes a significant, yet uncalculated contribution to pollution and the deterioration of the natural resource base on which tourism depends.

DETRIMENTAL IMPACTS OF COASTAL TOURISM

Tourism activities take place across the full range of coastal zone space, and as such, their impacts are spread over the entire zone (Figure 2). Island Resources Foundation (1996) developed a framework for the identification of potential tourism impact on coastal resources, and this is based on a combination of the type of tourist activity and the geographic zone in which these activities occur. The framework identified 252 potential impacts.

Impacts from Waste

Sewage has been identified as the largest single source of pollution to the coastal zone. A study by Simmons & Associates (1994) found that 80-90% of the sewage generated across the Caribbean is disposed of in the near-shore coastal waters without adequate treatment. Additionally, many areas are without central sewage systems, and disposal of sewage effluent takes place through sub-surface means.



Disposal of sewage and sewage effluent in coastal areas contaminate surface and ground water resources.

In many cases, contamination of the marine environment is immediate, as disposal takes place directly in the sea. Where sewage effluent is discharged to wetlands, other resources are affected before drainage to the marine environment.

Other non-point sources for pollution, including upstream sources, create impacts similar to those created by disposal of sewage effluent. These impacts include:

- Nutrient enrichment of surface and groundwater
- Deterioration of bathing and drinking water quality
- Outbreaks of disease
- Smothering of coral reefs by algal blooms
- Increased turbidity and reduced salinity in coastal waters close to outfall pipes and drains
- Red tides
- Fish kills
- Deterioration of the aesthetic quality of beaches and wetlands
- Odour problems

The impacts from solid waste disposal result from both legal and illegal disposal sites. Illegal dumping of solid waste results in visual impairment of areas, odour problems, deterioration of bathing and drinking water quality, and flooding (from blocked drains). If the definition of solid waste is broadened to include abandoned equipment and old vehicles, then the impact is much greater.

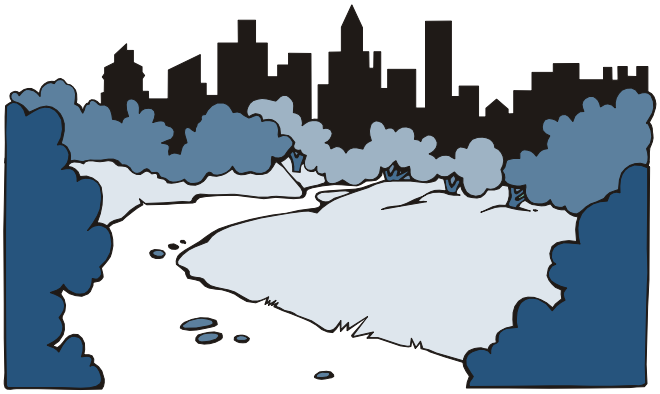
Impacts from Recreational Activities

The Caribbean has traditionally been marketed as a place for sun, sea and sand. This created a concentration of activities in the coastal area of each island. Impacts include:

- Concentration of sewage and other waste along coastal strips
- Increased accidents from water sports activities
- Increased deterioration of coral reefs, including dive sites
- Increased conflicts with other resource users, especially traditional users
- Erosion of beaches

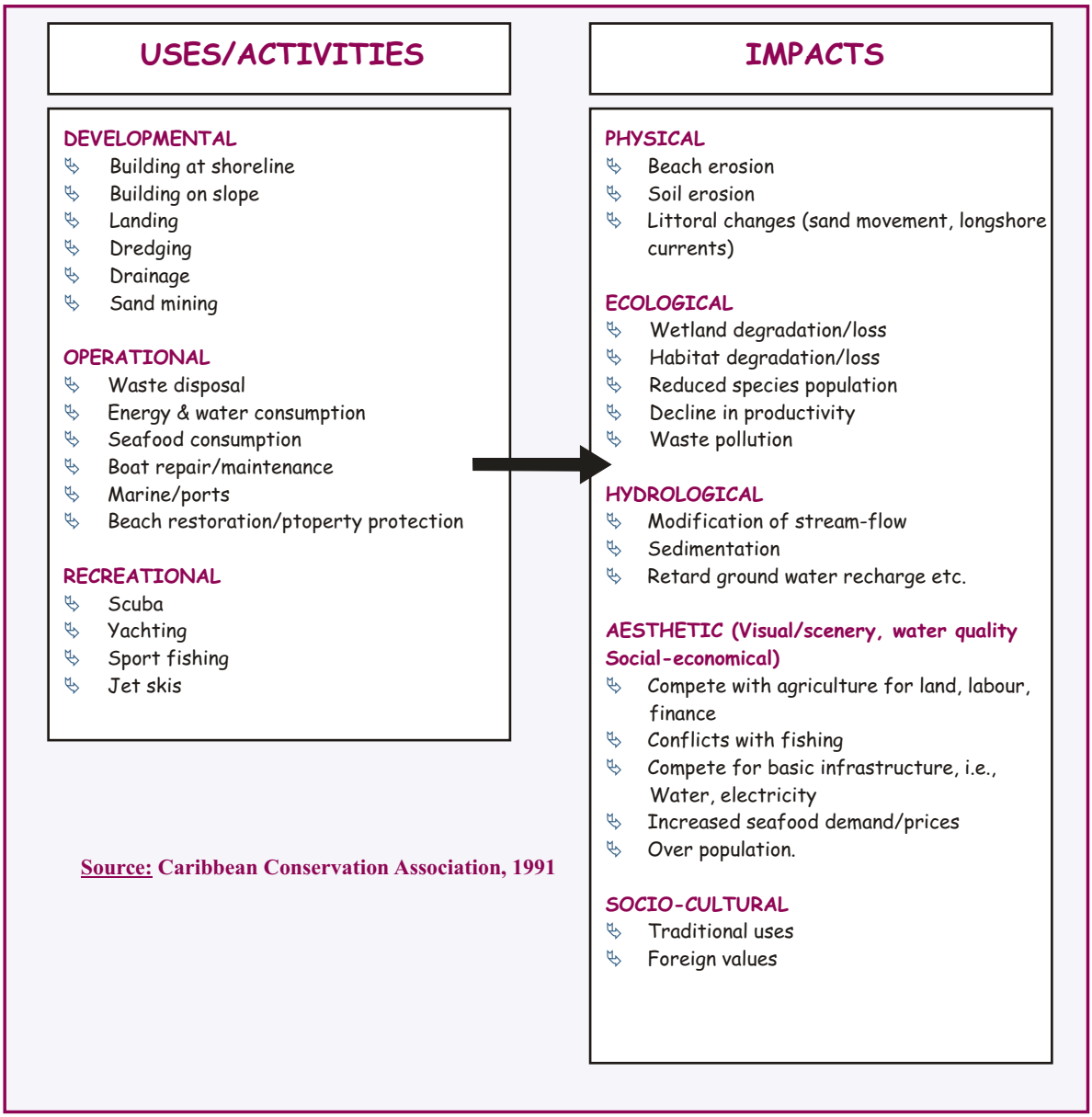
Physical Change/Mechanical Action

Physical change is a constant feature of tourism projects, as most concern some form of alteration of the environment to accommodate the desired facility. These projects range from construction of airports, hotels, and marinas to creation of beaches, sand mining, and removal of corals and seagrass.



Module 2- Figure 2:

Negative Impacts of Tourism in the Eastern Caribbean.



Source: Caribbean Conservation Association, 1991

The impacts of physical change include the following:

- Loss of valuable habitats which act as breeding grounds for many species of animals
- Scarring of landscapes
- Increased flooding of coastal areas through the loss of wetlands
- Deterioration of water quality through high sediment loading, interruption of current movement in bays, and inadequate solid waste disposal
- Erosion of beaches through improper placement of structures
- Noise pollution
- Loss of income by affected properties, enterprises, and resource users

Resource Over-use/Misuse

Resource overuse and misuse result from several factors and, in most cases, is only exacerbated by tourism. This includes the harvesting of wetland resources (fishing, charcoal production, production of craft items, etc.), stealing of beach sand, taking coral and other marine life for curios, and other similar uses of coastal resources (Table 5).

Module 2- Table 5:

Impacts of Activities Indirectly Related to Tourism

ACTIVITY	IMPACTS
Over-fishing	• Damage to reef (dynamiting, etc.) • Social conflicts
Harvesting of reef materials	• Coastal erosion • Loss of habitat for reef inhabitants • Loss of suitable materials for colonization by coral larvae • Social conflicts • International sanctions
Over-harvesting of trees/plants	• Coastal erosion • Destruction of wetlands • Decreasing income for uses of wetland resources • Social conflicts
Speculative land development	• High land costs • Pollution (inadequate infrastructure)

Carrying Capacity

The deteriorating quality of the environment is a clear indication that the uses of coastal resources exceed the ability of these natural systems to cope with the various uses. An ecosystem displaying degradation is therefore said to have exceeded its carrying capacity.

Factors to consider in determining the carrying capacity of an area:

- Site Vulnerability
- Resource Sensitivity
- Patterns of Use
- Tourism-specific Factors

A major problem in determining and managing carrying capacity is that the concept itself is, by nature, subjective. It is considered by many to be imprecise, difficult to quantify, difficult to implement, and at times confusing.

The determination of carrying capacity for a coastal ecosystem can be extremely complicated. Further, the definition of the concept can vary in scope and scale. Methodological and procedural guidelines have been proposed for tourism in coastal Mediterranean areas. Several factors need to be considered in an assessment of the carrying capacity of an area. These include site vulnerability, resource sensitivity, patterns of use and tourism specific factors. Two additional complicating factors are: (a) two or more agents of deterioration may act synergistically, and (b) some sources of degradation have several levels of impact; that is, they are expressed across several tropic levels of the ecosystem (Figure 3). Given the numerous examples where the carrying capacity of a tourism destination has been exceeded, there are clear benefits for the corrective application of a carrying capacity assessment. However, for the purpose of this Manual the carrying capacity concept is considered as an instrument to determine the desirable building density for a particular tourism development site (see Module 4).

Module 2- Figure 3:

Example of Multiple Levels of Impact From One Causal Factor

Factor:	High sediment loading to marine environment from surface run- off on a fairly regular basis.
Direct (Primary) Impact :	Smothering of adjacent coral reef.
Secondary Impact:	Death of coral reef results in: i. Reduced protection to the coastline ii. Loss of habitat for fish.
Tertiary Impact:	Decreased fish catch results in reduced earnings to fishermen.

The tertiary impact could also be the loss of earnings to the tourism sector if the coral reef is used to support diving or snorkeling activities in the tourism industry.

Most tourism site managers and regulators find it easier to maintain monitoring systems that are used to determine changes in the resource/system which is being utilised.

Environmental Indicators

Environmental indicators are usually selected as part of a series of actions in monitoring change in the environmental quality of the area (system) under scrutiny. An indicator denotes change from an actual to a desired state, or vice versa.

Environmental indicators can therefore be used in the following context:

Application of integrated coastal area planning and management are important as more Caribbean economies rely on tourism which is dependent to a large degree on good environmental quality.

- To monitor the performance of environmental policies
- To monitor the performance of institutions delivering environmental services
- To monitor the progress of a specific programme or action
- To monitor for selected changes in environmental quality

Indicators are usually specific to the situation under scrutiny, and are normally used as part of a formal process of monitoring change. Ideally, indicators should be denoted by specific values (e.g. concentration of oxides of sulphur or nitrogen in air quality monitoring), but can be more subjective (e.g. increased turbidity of water) if technological or cost limitations prevent more objective assessment.

Table 6 provides a general list of environmental issues, pressures and corresponding response measures as an example of the use of indicators as monitoring tool.

Criteria for Selection of Indicators

a. In terms of policy relevance and utility for users an environment indicator should:

- Provide a representative picture of environmental conditions, pressure on the environment, or society's response
- Be simple, easy to interpret, and able to show trends over time
- Be responsive to changes in the environment and related human activities
- Provide a basis for international comparison
- Be either national in scope or applicable to regional environmental issues of national significance
- Have a target or threshold against which to compare it so that users are able to assess the significance of the values associated with it

b. Analytical Soundness

An environmental indicator should:

- Be theoretically well-founded in technical and scientific terms
- Be based on international standards and international consensus about its validity
- Lend itself to be linked to economic models, forecasting, and information systems

c. Measurability

An environmental indicator should be:

- Readily available, or made available, at a reasonable cost/benefit ratio.
- Adequately documented and be of known quality.
- Updated at regular intervals.

In summary, the settlement pattern in many Caribbean countries, especially in the Insular Caribbean, is one of population concentration in urban areas located primarily in the coastal zone. As such, the coastal zone becomes an area in which most of the economic activities take place. However, the coastal zone is comprised of some of the most productive, diverse, and fragile ecosystems to be found on the planet.

The concentration of activities on these sensitive ecosystems results in resource degradation. In order to address this problem, the concept of carrying capacity within a broad framework of integrated coastal area management has been articulated and, in some cases, applied.

However, while large systemic changes are often difficult to undertake, the tourism industry itself has to be the major agent of change. Although there is growing awareness of the need to "green" properties and operations, this movement is being approached as a marketing matter, and generally without any apparent understanding of the need to protect their investments through the application of environmentally sound practices.

Module 2-Table 6:
Matrix Of Environmental Indicators

Environmental Issues	Pressure	State	Response
Climate Change	(GHG) emissions	Concentrations	Energy intensity; env. Measures
Ozone Depletion	(Halocarbon) emissions; Production	(Chlorine) concentrations; O_3 column	Protocol sign.; CFC recovery; Fund contrib'n
Eutrophication	(N,P water, soil) Emissions	(N, P, BOD) concentrations	Treatm. Connect; investments/costs
Acidification	(SO_x, NO_x, NH_3) Emissions	Deposition; concentrations	Investments; sign. Agreements
Toxic Contamination	(POC, heavy metal) emissions	(POC, heavy metal) concentrations	Recovery hazardous waste; investments/costs
Urban Env. Quality	(VOC, NO_x, SO_x) emissions	(VOC, Nox, So_x) concentrations	Expenditures; transp. Policy
Biodiversity	Land conversion; land fragmentation	Species abundance comp. to virgin area	Protected areas
Waste	Waste generation mun'pal, ind. Agric	Soil/groundwater quality	Collection rate; recycling investments/costs
Water Resources	Demand/use intensity resid. ind./agric.	Demand/supply ratio; quality	Expenditures; water pricing; savings policy
Forest Resources	Use intensity	Area degr. forest; use/sustain. Growth ratio	Protected area forest, sustain. Logging
Fish Resources	Fish catches	Sustainable stocks	Quotas
Soil Degradation	Land use changes	Top soil loss	Rehabilitation/protection
Oceans/Coastal Zones	Emissions; oil spills; depositions	Water quality	Coastal zone management; ocean protection